SOLVENT COMPOSITION FOR DISSOLVING PLASTIC

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a solvent composition for dissolving plastic.

Description of the Related Art

Fluorine-based and chlorine-based solvent compositions have been widely used as solvent compositions for dissolving plastic. In recent years, however, the influence that fluorine-based solvents and chlorine-based solvents have on the environment has been largely perceived as an environmental problem, and regulations regarding use of such solvents are becoming stricter every year. Under such circumstances, in recent years, solvents that use bromohydrocarbon compounds, such as isopropyl bromide (referred to as "IPB" below) and n-propyl bromide (referred to as "NPB" below), as main ingredients have been proposed as a new type of solvent composition that serve as an alternative to fluorine-based and/or chlorine-based solvent compositions.

For example, Japanese Patent Application Laid-open Publication No. 8-337795 (Japanese Patent Application No. 8-85268) discloses a cleaning solvent that uses 1-bromopropane as a main ingredient and to which nitromethane and the like is added as a stabilizer. Japanese Patent No. 2576933 (Japanese Patent Application Laid-open Publication No. 6-220494) discloses a cleaning solvent that uses IPB or NPB as a main ingredient, but does not include any fluorine-based or chlorine-based solvent, and to which at least one type of compound selected from a group consisting of nitroalkanes and the like is added as a stabilizer.

Further, Japanese Patent Application Laid-open Publication No. 9-302389 (Japanese Patent Application No. 8-121634) discloses a cleaning solvent that uses IPB and/or NPB as a main ingredient and to which nitroalkane and butylene oxide are added as stabilizers.

However, these cleaning solvents that use IPB and/or NPB as a main ingredient do not have the ability to dissolve various kinds of plastics such as polyester resin, acrylic resin, and phenolic resin. For this reason, such cleaning solvents could not be used as an alternative to chlorine-based solvents such as methylene chloride that have been used for dissolving plastics. Therefore, for the purpose of dissolving plastic, chlorine-based solvents such as methylene chloride have to be used within the amount restricted by regulations.

Japanese Patent Application Laid-open Publication No. 11-172290 (Japanese Patent Application No. 9-341644) discloses a solvent having an organic solvent blended to IPB or NPB and having the ability to dissolve plastic. However, since the solvent includes an organic solvent, there exist such problems as that the solvent has slight flammability and that the solvent might cause environmental problems.

Therefore, a solvent for dissolving plastic that uses IPB or NPB, which has slight or no influence on the environment, as a main ingredient, that has a great ability to dissolve various kinds of plastics, and that has no flammability has been long desired.

SUMMARY OF THE INVENTION

The present invention has been made in view of the circumstances described above, and an object thereof is to provide

a plastic-dissolving solvent composition that uses IPB or NPB as a main ingredient, that has the ability to dissolve plastic, and that has no flammability.

One aspect of the present invention is a solvent composition for dissolving plastic comprising: at least either isopropyl bromide or n-propyl bromide; and at least either nitromethane or nitroethane, wherein the content of the above-mentioned at least either nitromethane or nitroethane is 5 through 50 wt% with respect to the entire amount of the solvent.

Another aspect of the present invention is a solvent composition for dissolving plastic comprising: at least either isopropyl bromide or n-propyl bromide; and N-methyl pyrrolidone, wherein the content of N-methyl pyrrolidone is 5 through 85 wt% with respect to the entire amount of the solvent.

Features and objects of the present invention other than the above will become clear by reading the description of the present specification with reference to the accompanying drawings.

DETAILED DESCRIPTION OF THE INVENTION

The present inventor has found that the above-mentioned problems can be solved by adding at least either one of nitroethane or nitromethane to IPB and/or NPB and making the content of nitroethane and/or nitromethane be 5 through 50 wt% with respect to the entire amount of the solvent. The present inventor has also found that the above-mentioned problems can be solved by adding N-methyl pyrrolidone to IPB and/or NPB and making the content of N-methyl pyrrolidone be 5 through 85 wt% with respect to the entire amount of the solvent. The present invention has been arrived according to such findings.

The present invention is described in detail below.

The solvent composition for dissolving plastic according to the present invention includes IPB and/or NPB. IPB and NPB have superior features as a solvent in terms that they have low toxicity, they are nonflammable, they are nonaqueous, and that they are recyclable by distillation. NPB has lower toxicity compared to IPB, and therefore, it can be used more preferably. In the solvent composition for dissolving plastic according to the present invention, the content of IPB and/or NPB is generally 50 through 95 wt%, and preferably 60 through 90 wt %, with respect to the entire amount of the solvent. If both IPB and NPB are used, the compositional ratio between IPB and NPB can be set freely.

Nitromethane and nitroethane used in the present invention are preferable because they have low toxicity. Further, nitroethane has been confirmed to have no carcinogenicity, and therefore, nitroethane is used most preferably. Further, nitroethane and nitromethane and NPB and/or IPB become an azeotrope, and therefore, it is possible to easily recycle the solvent by distillation. In the solvent composition of the present invention, the content of nitroethane and/or nitromethane is generally 5 through 50 wt%, preferably 10 through 40 wt%, and more preferably approximately 30 wt%, with respect to the entire amount of the solvent. When the content of nitroethane and/or nitromethane contained in the solvent is within the above-mentioned range, both the ability to dissolve plastic and the ability to clean flux are high and balanced and is thus preferable.

Further, N-methyl pyrrolidone (referred to also as "NMP" below) used in the present invention is preferable in terms that it has superior dissolving ability. In the solvent composition

of the present invention, the content of N-methyl pyrrolidone is generally 5 through 85 wt%, and preferably 10 through 85 wt%, with respect to the entire amount of the solvent. When the content of N-methyl pyrrolidone contained in the solvent is within the above-mentioned range, both the ability to dissolve plastic and the ability to clean flux are high and balanced and is thus preferable.

Further, other than the above-mentioned compounds, the solvent composition of the present invention may include a small amount of fluorine-based solvent. By containing a small amount of fluorine-based solvent, it is possible to reduce the surface tension of the solvent and improve permeability of the solvent. Examples of such a fluorine-based solvent include the following: $C_5H_2F_{10}$, $C_4F_9OCH_3$, $C_4F_9OC_2H_5$, $(CF_3)_2NCH_2CF_2H$, $(CF_3)_2NCH_2CF_3$, $(CF_3)_2NCH_2CH_3$, $(CF_3)_2NC_3H_7$, CH_3CCl_2F, $CH_3CF_2HCl_2$, $CClF_2CF_2CHClF$, $CF_3CF_2CH_2OH$, CF_3CH_2OH, and $CF_3CH_2CF_2CH_3$. The content of the fluorine-based solvent is generally 0.1 through 10.0 wt%, and preferably 0.5 through 1.0 wt%, with respect to the entire amount of the solvent. It should be noted that the solvent composition of the present invention does not have to include such a fluorine-based solvent.

The solvent composition of the present invention may include the following additional ingredients: bromine-based solvents other than IPB and NPB; organic solvents such as acetone, dimethylformamide, ethyl acetate, and ethyl lactate; other substances that can be used as solvents; and stabilizers such as phenols, amines, ethers, amilene, esters, organic phosphates, epoxides, furans, alcohols, ketones, and triazoles. Further, the solvent composition for dissolving plastic of the present invention may include any other kinds of substances as long as

they do not impair the effect of the present invention.

The solvent for dissolving plastic according to the present invention is prepared by mixing some or all of the ingredients described above, and the method for mixing the ingredients is not limited to a particular method.

Other than for dissolving plastics, the solvent for dissolving plastic of the present invention may be used for cleaning flux, for stripping off or removing plastic films, for coatings, and for adhesives. Plastics that can be dissolved include, but are not limited to, the following: polyester resin, acrylic resin, phenoxy resin, polysulfone resin, styrene resin, epoxy resin, phenolic resin, polycarbonate resin, vinyl acetate resin, polyurethane resin, polyamide resin, polystyrol resin, and cellulose resin. Polyester resin includes, but is not limited to, polyethylene terephthalate, alkyd resin, saturated polyester resin, and unsaturated polyester resin.

The solvent for dissolving plastic according to the present invention can be suitably used as an alternative to methylene chloride.

<< Examples >>

The present invention will be described more specifically according to the following examples.

< Working Examples 1-9, Comparative Examples 1-4 >

As working examples 1-9 and comparative examples 1-4, solvents including NPB and nitroethane having the composition described in Table 1 were prepared. The ability to dissolve resin, the ability to clean flux, and flammability were tested for each of the working examples 1-9 and comparative examples 1-4. The results are shown in Table 1.

It should be noted that, as for the test for the ability to dissolve resin, test specimens having a weight of 5 g and made of the different types of resins shown in Table 1 were each supplied to an Erlenmeyer flask (100 ml) along with 50 g of each of the dissolving agent (working examples 1-9 and comparative examples 1-4) and stirred for 5 hours at 25 °C. The dissolution states of each resin were tested. The test results are evaluated in Table 1 according to the following three levels: the resin dissolved completely (VG: very good); the resin dissolved slightly (G: good); and the resin did not dissolve at all (×: poor).

Further, as for the evaluation for the ability to clean flux, an Omegameter, which is generally used for evaluating the cleaning ability of a cleaning liquid, was used. Generally, in an Omegameter, contaminants on, for example, printed wiring boards are dissolved in the solution subjected to measuring, and the electrical conductivity of the solution is measured to evaluate the degree of contamination. With the Omegameter, the degree of contamination of the part before cleaning and the degree of contamination of the part after cleaning were measured, and based on the measurement value, the cleaning ability of each solvent was derived. The results are evaluated in Table 1 in the following three levels according to the amount of time required for cleaning: cleaning was possible in a short amount of time (VG: very good); a long amount of time was required for cleaning (G: good); and cleaning was not possible (×: poor).

Flammability was tested according to the Tag closed cup method.

Table 1

	NPB (wt%)	nitro-ethane (wt%)	poly-ester	acrylic resin	poly-carbo-nate	phenoxy resin	poly-sulfone	styrene resin	flux-cleaning ability	flamma-bility
comparative example 1	100	0	×	×	G	×	×	VG	G	no
comparative example 2	97	3	×	×	G	×	×	VG	G	no
working example 1	95	5	G	×	G	G	×	VG	VG	no
working example 2	90	10	G	G	VG	G	G	VG	VG	no
working example 3	85	15	G	G	VG	G	G	VG	VG	no
working example 4	80	20	G	G	VG	G	G	VG	VG	no
working example 5	75	25	VG	G	VG	VG	G	VG	VG	no
working example 6	70	30	VG	VG	VG	VG	VG	VG	VG	no
working example 7	65	35	VG	VG	G	VG	VG	VG	VG	no
working example 8	60	40	VG	VG	G	VG	VG	VG	G	no
working example 9	50	50	VG	VG	×	VG	VG	VG	G	no
comparative example 3	45	55	VG	VG	×	VG	VG	VG	G	yes
comparative example 4	0	100	×	×	×	×	×	G	G	yes

VG: very good G: good x: poor

As shown in Table 1, it was found that the ability to dissolve resin increases as the content amount of nitroethane is increased. The ability to clean flux was generally good for all tests. However, it was found that if the content amount of nitroethane is too high, the amount of time required for flux cleaning becomes long. Further, it was found that flammability became present when the content amount of nitroethane exceeded 55 wt%.

From these results, it was found that when the content amount of nitroethane is within the range of 5 through 50 wt% with respect to the entire amount of the solvent, it is possible to dissolve plastics such as polyesters and phenoxy resin and the solvent has flux-cleaning ability and is nonflammable, and therefore it is preferable. Further, it was found that when the content amount of nitroethane is within the range of 10 through 40 wt% with respect to the entire amount of the solvent, it is possible to dissolve plastics such as acrylic resin and polysulfone resin, and therefore it is more preferable. Furthermore, it was found that it is possible to clean flux in a short amount of time when the content amount of nitroethane is at most 35 wt% with respect to the entire amount of the solvent.

< Working Examples 10-18, Comparative Examples 5-7 >

Next, tests similar to those for the above-mentioned working examples 1-9 and comparative examples 2-4 were carried out, except that nitromethane was used instead of nitroethane. Solvents having the composition as described in Table 2 were prepared. It should be noted that each test was carried out in the same way as that described above. The test results are shown in Table 2.

Table 2

	NPB (wt%)	nitro-methane (wt%)	poly-ester	acrylic resin	poly-carbo-nate	phenoxy resin	poly-sulfone	styrene resin	flux-cleaning ability	flamma-bility
comparative example 5	97	3	×	×	G	×	×	VG	G	no
working example 10	95	5	G	×	G	G	×	VG	VG	no
working example 11	90	10	G	G	VG	G	G	VG	VG	no
working example 12	85	15	G	G	VG	G	G	VG	VG	no
working example 13	80	20	G	G	VG	G	G	VG	VG	no
working example 14	75	25	VG	G	VG	VG	G	VG	VG	no
working example 15	70	30	VG	VG	VG	VG	VG	VG	VG	no
working example 16	65	35	VG	VG	G	VG	VG	VG	VG	no
working example 17	60	40	VG	VG	G	VG	VG	VG	G	no
working example 18	50	50	VG	VG	×	VG	VG	VG	G	no
comparative example 6	45	55	VG	VG	×	VG	VG	VG	G	yes
comparative example 7	0	100	×	×	×	×	×	G	G	yes

VG: very good G: good x: poor

As shown in Table 2, it was found that results similar to those for when using nitroethane are obtained even when using nitromethane instead of nitroethane.

< Working Examples 19-27, Comparative Examples 8-10 >

Next, tests similar to those for the above-mentioned working examples 1-9 and comparative examples 2-4 were carried out, except that N-methyl pyrrolidone was used instead of nitroethane. Solvents having the composition as described in Table 3 were prepared. It should be noted that each test was carried out in the same way as that described above. The test results are shown in Table 3.

Table 3

	NPB (wt%)	NMP (wt%)	poly-ester	acrylic resin	poly-carbo-nate	phenoxy resin	poly-sulfone	styrene resin	flux-cleaning ability	flamma-bility
comparative example 8	97	3	×	×	G	×	×	VG	G	no
working example 19	95	5	G	×	G	G	×	VG	VG	no
working example 20	90	10	G	G	VG	G	G	VG	VG	no
working example 21	85	15	G	G	VG	G	G	VG	VG	no
working example 22	80	20	G	G	VG	G	G	VG	VG	no
working example 23	75	25	VG	G	VG	VG	G	VG	VG	no
working example 24	70	30	VG	VG	VG	VG	VG	VG	VG	no
working example 25	50	50	VG	VG	VG	VG	VG	VG	VG	no
working example 26	30	70	VG	VG	VG	VG	VG	VG	VG	no
working example 27	15	85	VG	VG	VG	VG	VG	VG	VG	no
comparative example 9	10	90	VG	VG	VG	VG	VG	VG	VG	yes
comparative example 10	0	100	VG	VG	VG	VG	VG	VG	VG	yes

VG: very good G: good x: poor

As shown in Table 3, similar to the solvents including nitroethane or nitromethane, it was found that the solvents including N-methyl pyrrolidone of working examples 19-27 have the ability sufficient for dissolving various kinds of plastics. Further, it was found that the solvents including N-methyl pyrrolidone are very preferable since their ability to dissolve plastic does not weaken even when the content amount of N-methyl

pyrrolidone is 50 wt% or more compared to the solvents including nitroethane or nitromethane.

< Working Examples 28-36, Comparative Examples 11-13 >

Next, tests similar to those for the above-mentioned working examples 1-9 and comparative examples 1-3 were carried out, except that IPB was used instead of NPB. Solvents having the composition as described in Table 4 were prepared. It should be noted that each test was carried out in the same way as that described above. The test results are shown in Table 4.

Table 4

	IPB (wt%)	nitro-ethane (wt%)	poly-ester	acrylic resin	poly-carbo-nate	phenoxy resin	poly-sulfone	styrene resin	flux-cleaning ability	flamma-bility
comparative example 11	100	0	×	×	G	×	×	VG	G	no
comparative example 12	97	3	×	×	G	×	×	VG	G	no
working example 28	95	5	G	×	G	G	×	VG	VG	no
working example 29	90	10	G	G	VG	G	G	VG	VG	no
working example 30	85	15	G	G	VG	G	G	VG	VG	no
working example 31	80	20	G	G	VG	G	G	VG	VG	no
working example 32	75	25	VG	G	VG	VG	G	VG	VG	no
working example 33	70	30	VG	VG	VG	VG	VG	VG	VG	no
working example 34	65	35	VG	VG	G	VG	VG	VG	VG	no
working example 35	60	40	VG	VG	G	VG	VG	VG	G	no
working example 36	50	50	VG	VG	×	VG	VG	VG	G	no
comparative example 13	45	55	VG	VG	×	VG	VG	VG	G	yes

VG: very good G: good x: poor

As shown in Table 4, it was found that results similar to those for when using NPB are obtained even when IPB is used instead of NPB as the solvent.

< Working Examples 37-45, Comparative Examples 14-15 >

Next, tests similar to those for the above-mentioned working examples 10-18 and comparative examples 5-6 were carried out, except that IPB was used instead of NPB. Solvents having the composition as described in Table 5 were prepared. It should be noted that each test was carried out in the same way as that described above. The test results are shown in Table 5.

Table 5

	IPB (wt%)	nitro-methane (wt%)	poly-ester	acrylic resin	poly-carbo-nate	phenoxy resin	poly-sulfone	styrene resin	flux-cleaning ability	flamma-bility
comparative example 14	97	3	×	×	G	×	×	VG	G	no
working example 37	95	5	G	×	G	G	×	VG	VG	no
working example 38	90	10	G	G	VG	G	G	VG	VG	no
working example 39	85	15	G	G	VG	G	G	VG	VG	no
working example 40	80	20	G	G	VG	G	G	VG	VG	no
working example 41	75	25	VG	G	VG	VG	G	VG	VG	no
working example 42	70	30	VG	VG	VG	VG	VG	VG	VG	no
working example 43	65	35	VG	VG	G	VG	VG	VG	VG	no
working example 44	60	40	VG	VG	G	VG	VG	VG	VG	no
working example 45	50	50	VG	VG	×	VG	VG	VG	G	no
comparative example 15	45	55	VG	VG	×	VG	VG	VG	G	yes

VG: very good G: good x: poor

As shown in Table 5, it was found that results similar to those for when using NPB are obtained even when IPB is used instead of NPB as the solvent.

< Working Examples 46-54, Comparative Examples 16-17 >

Next, tests similar to those for the above-mentioned working examples 19-27 and comparative examples 8-10 were carried out, except that IPB was used instead of NPB. Solvents having the composition as described in Table 6 were prepared. It should be noted that each test was carried out in the same way as that described above. The test results are shown in Table 6.

Table 6

	IPB (wt%)	NMP (wt%)	poly-ester	acrylic resin	poly-carbo-nate	phenoxy resin	poly-sulfone	styrene resin	flux-cleaning ability	flamma-bility
comparative example 16	97	3	×	×	G	×	×	VG	G	no
working example 46	95	5	G	×	G	G	×	VG	VG	no
working example 47	90	10	G	G	VG	G	G	VG	VG	no
working example 48	85	15	G	G	VG	G	G	VG	VG	no
working example 49	80	20	G	G	VG	G	G	VG	VG	no
working example 50	75	25	VG	G	VG	VG	G	VG	VG	no
working example 51	70	30	VG	VG	VG	VG	VG	VG	VG	no
working example 52	50	50	VG	VG	VG	VG	VG	VG	VG	no
working example 53	30	70	VG	VG	VG	VG	VG	VG	VG	no
working example 54	15	85	VG	VG	VG	VG	VG	VG	VG	no
comparative example 17	10	90	VG	VG	VG	VG	VG	VG	VG	yes

VG: very good G: good x: poor

As shown in Table 6, it was found that results similar to those for when using NPB are obtained even when IPB is used instead of NPB as the solvent.

< Working Examples 55-63, Comparative Examples 18-19 >

Next, tests similar to those for the above-mentioned working examples 1-9 and comparative examples 2-3 were carried out, except that a "mixture of nitroethane and nitromethane" was used instead of "nitroethane". Solvents having the composition as described in Table 7 were prepared. It should be noted that each test was carried out in the same way as that described above. The test results are shown in Table 7.

Table 7

	NPB (wt%)	nitro-ethane (wt%)	nitro-methane (wt%)	poly-ester	acrylic resin	poly-carbo-nate	phenoxy resin	poly-sulfone	poly-styrene	flux-cleaning ability	flamma-bility
comparative example 18	97	1.5	1.5	×	×	G	×	×	VG	G	no
working example 55	95	2.5	2.5	G	×	G	G	×	VG	VG	no
working example 56	90	5.0	5.0	G	G	VG	G	G	G	VG	no
working example 57	85	7.5	7.5	G	G	VG	G	G	VG	VG	no
working example 58	80	10.0	10.0	G	G	VG	G	G	VG	VG	no
working example 59	75	12.5	12.5	VG	G	VG	VG	G	VG	VG	no
working example 60	70	15.0	15.0	VG	VG	VG	VG	VG	VG	VG	no
working example 61	65	17.5	17.5	VG	VG	G	VG	VG	VG	VG	no
working example 62	60	20.0	20.0	VG	VG	G	VG	VG	VG	G	no
working example 63	50	25.0	25.0	VG	VG	×	VG	VG	VG	G	no
comparative example 19	45	27.5	27.5	VG	VG	×	VG	VG	VG	G	yes

VG: very good G: good x: poor

As shown in Table 7, it was found that results similar to those for when using nitroethane are obtained even when a "mixture of nitroethane and nitromethane" is used instead of "nitroethane" used in the above-mentioned working examples 1-9 and comparative examples 2-3.

< Working Examples 64-72, Comparative Examples 20-21 >

Next, tests similar to those for the above-mentioned working examples 55-63 and comparative examples 18-19 were carried out, except that IPB was used instead of NPB. Solvents having the composition as described in Table 8 were prepared. It should be noted that each test was carried out in the same way as that described above. The test results are shown in Table 8.

Table 8

	IPB (wt%)	nitro-ethane (wt%)	nitro-methane (wt%)	poly-ester	acrylic resin	poly-carbo-nate	phenoxy resin	poly-sulfone	poly-styrene	flux-cleaning ability	flamma-bility
comparative example 20	97	1.5	1.5	×	×	G	×	×	VG	G	no
working example 64	95	2.5	2.5	G	×	G	G	×	VG	G	no
working example 65	90	5.0	5.0	G	G	VG	G	G	G	VG	no
working example 66	85	7.5	7.5	G	G	VG	G	G	VG	VG	no
working example 67	80	10.0	10.0	G	G	VG	G	G	VG	VG	no
working example 68	75	12.5	12.5	VG	G	VG	VG	G	VG	VG	no
working example 69	70	15.0	15.0	VG	VG	VG	VG	VG	VG	VG	no
working example 70	65	17.5	17.5	VG	VG	G	VG	VG	VG	VG	no
working example 71	60	20.0	20.0	VG	VG	G	VG	VG	VG	G	no
working example 72	50	25.0	25.0	VG	VG	×	VG	VG	VG	G	no
comparative example 21	45	27.5	27.5	VG	VG	×	VG	VG	VG	G	yes

VG: very good G: good x: poor

As shown in Table 8, it was found that results similar to those for the above-mentioned working examples 55-63 using NPB are obtained even when IPB is used instead of NPB.

The solvent composition for dissolving plastic according to the present invention has low toxicity compared to conventional chlorine-based solvents because the present solvent uses IPB or NPB as the main ingredient. Further, since the solvent according to the present invention is nonflammable, it is extremely safe to use and easy to handle. Furthermore, since the solvent according to the present invention has a great ability to dissolve plastics such as resin, it can be suitably used as a solvent for stripping off or removing plastic films, as a solvent for coatings, or as a solvent for adhesives, other than for cleaning.

Although the preferred embodiment of the present invention has been described in detail, it should be understood that various changes, substitutions and alterations can be made therein without departing from spirit and scope of the inventions as defined by the appended claims.